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Transitional path to the adoption of nature-based solutions

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ABSTRACT

Spatial planning of green infrastructure has become well established since the turn of the millennium. However, as a planning and policy concept alone it lacks the focus and immediacy that decision makers may be looking for to solve current problems associated with urban and extra-urban sustainability and resilience. In nature-based solutions decision makers can find the focus and immediacy they are seeking. We posit that these nature-based solutions used in combination with spatial green infrastructure planning have the capacity to rival, replace or combine with existing grey infrastructure approaches. Nevertheless, there is a major inhibitor of change to be overcome. This is 'path dependence', a concept where active memory conditioned by past decisions has a controlling influence on decision making. This concept leads to self-reinforcement that is detrimental to the creation of climate-sensitive infrastructure. Unless path dependence is broken through a combination of reforms, the shift towards the full adoption of nature-based solutions will not occur. A transition path covering four areas is proposed, which will help to overcome path dependence and lead to a greater use of nature-based solutions. We argue that the forum to debate these proposals is within the framework of UN Habitat. The Urban Thinkers Campus and World Urban Forum could be the fora for this exchange.

1. Introduction

The constructed assets concept, contemporarily described as being mainly 'grey', has dominated most forms of infrastructure thinking worldwide along the course of human history. The discourse on the Anthropocene and an increasing understanding of ecosystem limits have more recently contributed to the evolution of the concept of spatial green infrastructure. A move from grey towards green infrastructure is considered a highly desirable prospect to address the intense pressures of rapid urbanisation and climate change. As an approach to spatial planning green infrastructure has become well established, but in our experience, having spent the last two decades in the field as a policy practitioner and researcher, respectively, we have come to believe that as a planning and policy concept alone it lacks the focus and immediacy that decision makers are looking for to solve their current problems. In nature-based solutions decision makers can find the focus and immediacy they are seeking. We posit that these nature-based solutions have the capacity to rival, replace or combine with the existing grey infrastructure approach. This can lead towards more resilient and sustainable cities (EC, 2015) and extra-urban landscapes. Nature-based solutions enable sustainable urbanisation, improve risk management and ecosystem resilience in the face of global climate change. However, we believe that there is a major inhibitor of change, which is 'path dependence', a concept where active memory conditioned by past decisions has a controlling influence on decision making. This concept leads to self-reinforcement that is detrimental to the creation of climate-sensitive infrastructure. Unless path dependence is broken through a combination of radical reforms, the shift towards the full adoption of nature-based solutions will not occur.

2. The path to transition

In 312 BCE, the renowned Roman censor Appius Claudius Caecus, popularly known as 'the blind', commissioned Ancient Rome's first major aqueduct and Appian Way (Martini, 1976). These historic achievements still shape the mindset of infrastructure builders over two millennia later. He probably did not envisage that the mould he and his illustrious successors were casting would later be termed 'grey infrastructure'. Grey infrastructure is manmade improvements that support and improve human settlement such as roads, power lines, water systems, schools and hospitals (EEA, 2011).

The world of the pre-modern age Roman censor is far remote from

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the highly human-influenced planet of 7.6 billion that exists today. Indeed, the discourse on the Anthropocene (Monastersky, 2015) has led to a deeper understanding of ecosystem limits and, in turn, contributed to the recent evolution of the concept of 'green infrastructure' (Benedict and McMahon, 2002). Green infrastructure is sometimes viewed as a contested term (Davies et al., 2006; Wright, 2011). However, powerful international actors, such as the European Union, have defined it as a 'strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services' (EC, 2013), a definition regularly used across practice, academia and policy literature (see, e.g., Maes et al. (2015) and Escobedo et al. (2018) for spatial, health and other aspects of the definition of green infrastructure).

The authors, who in a long-standing professional relationship have been working closely on the development of the green infrastructure concept from a policy practitioner and scientific researcher perspective, respectively, consider that a transformative outlook which breaks the mould of historic grey infrastructure approaches towards those that are climate sensitive is extremely urgent. Expressly, we posit that policy makers must envision a future where nature should be employed rather than conquered and used in tandem with existing approaches. As a consequence, so-called nature-based solutions should become part of the 'new normal' in infrastructure management. Nature-based solutions have been defined as "living solutions inspired by, supported by or copied from nature, which are designed to address various societal challenges in a resource-efficient and adaptable manner and to provide simultaneously economic, social and environmental benefits" (EC, 2015; Lafortezza et al., 2018). Nature-based solutions are also the result of sets of practices and activities that contribute to improving human wellbeing and quality of life (Escobedo et al., 2018). To make nature-based solutions the new normal, we set out a prescription of key reforms (see below).

Nature-based solutions are interventions that have the potential to restore degraded ecosystems and maximise their performance (i.e., ecosystem services) to mitigate and adapt to climate change effects (EC, 2015; Faivre et al., 2017; Nikolaidis et al., 2017; Wamsler et al., 2017). For this to occur we believe, *inter alia*, that the foundation for nature-based solutions is a well-performing spatially based green infrastructure (Mell et al., 2009; Hansen and Pauleit, 2014; Asian Development Bank, 2016). Critically, nature-based solutions should not be considered as new interventions alone, but also as tools to properly maintain existing green infrastructure.

Despite the evidence being gathered in favour of nature-based solutions, there is a serious impediment to be overcome, which for the most part authors have either ignored or chosen to skirt around. For historical and cultural reasons, grey infrastructure continues to dominate the delivery and management of services. On closer examination, these approaches exhibit the characteristics of 'path dependence' (Vergne and Durand, 2010). Path dependence describes the situation where active memory conditioned by past decisions has a controlling influence on decision making (Liebowitz and Margolis, 1995). This leads to lock-ins and errors being made and repeated again and again despite voluntary decision making and enlightened self-interest.

The authors believe that path dependence constitutes the most significant brake on the uptake of nature-based solutions and, as a consequence, the infrastructure of cities and extra-urban landscapes is less than optimal. Why has this become increasingly significant? The answer lies in the potential of nature-based solutions to counter the negative impacts of rapid urbanisation and climate change within the wider context of the challenges set out in the United Nations' New Urban Agenda (UN, 2016).

It has been proposed that for the successful uptake of nature-based solutions, bottom-up collaborative partnerships are necessary along with their replicability (Kabisch et al., 2017a). We concur with Raymond et al. (2017) that nature-based solutions impacts are likely to be multidirectional and complex and that the benefits can be best understood by addressing challenges that are cross-sectoral and span the environmental, socio-cultural and economic domains. In fact, McPhearson et al. (2016) contend that integrated science has the potential to inform decision makers who stand in need of a deeper understanding of complex relationships among social, ecological, economic, and built infrastructure systems. Extending this argument, Kabisch et al. (2016) claim that nature-based solutions also produce additional benefits for societal wellbeing and serve as a strong investment option for sustainable urbanisation. This appears to be especially true with respect to water purification, flood protection and urban temperature mitigation (Alexandri and Jones, 2008) where nature-based solutions contingent upon a spatial green infrastructure network perform equally or even better than grey infrastructure and have similar costs (Liquete et al., 2016). Depietri and McPhearson (2017) argue that a multi-disciplinary and integrated approach is needed and that a social-ecological-technological systems (SETs) approach provides a useful framework.

Our argument in favour of breaking the mould of path dependence does not imply that we have rejected the need for grey solutions, but only that decision makers should be able to make an informed choice independent of self-reinforcing norms. Indeed, we have concluded that in all likelihood the 'real world' would benefit from the integration of grey and green infrastructure (Maes et al., 2015), so that nature-based solutions operate in combination with existing approaches. Support for this is found in Depietri and McPhearson (2017) who propose an approach based on green, grey and hybrid infrastructure, the latter describing a combination of both green and grey. Integration can also be found in reports from important global institutions. For example, the Asian Development Bank (2016) case studies from the greater Mekong subregion have considered the application of nature-based solutions for building resilience in respect of water and flood management, slope stability and pollution management. The lessons provided highlight how a change in current planning strategies should focus on the need to rehabilitate natural systems alongside existing approaches. Hence, nature-based solutions are seen as contributing to solving a broad range of climate change-related issues such as assessing climate change impacts and vulnerabilities, identifying and prioritising adaptation measures and preparing and implementing adaptation plans, also in the context of populations' sense of place with implications for resilience and transformative capacity (Masterson et al., 2017).

To break the path dependence that currently favours grey infrastructure a quantum shift in reasoning and radical reforms is needed, because "progress is impossible without change, and those who cannot change their minds cannot change anything" – *George Bernard Shaw (1856–1950)*. Encouragingly, the European Commission now feels sufficiently confident to claim that "Green infrastructure planning is a successfully tested tool to provide environmental, economic and social benefits through natural solutions and help[s] reduce dependence on grey infrastructure that is often more expensive to build and maintain" (EC, 2013). To achieve transformation, we believe that no single action will suffice. We also support the argument made by Maes and Jacobs (2017) that a transition path will be required. Furthermore, as proposed in Kabisch et al. (2017b), the transition path for the wider uptake of nature-based solutions requires active cooperation and minimal compartmentalisation as a precondition.

The transition path we propose is based on simultaneous reforms in four areas: (i) education of existing and future infrastructure professionals; (ii) reform of institutions and their cultures; (iii) community-empowered placemaking combined with 'ecosystem literacy'; and (iv) a new approach to public and private sector procurement (see Fig. 1). Collectively, these may tip the balance in favour of an appropriate and equitable use of both grey, green and hybrid infrastructure approaches and enable a much wider uptake of nature-based solutions capable of tackling climate change issues in a rapidly urbanising world.

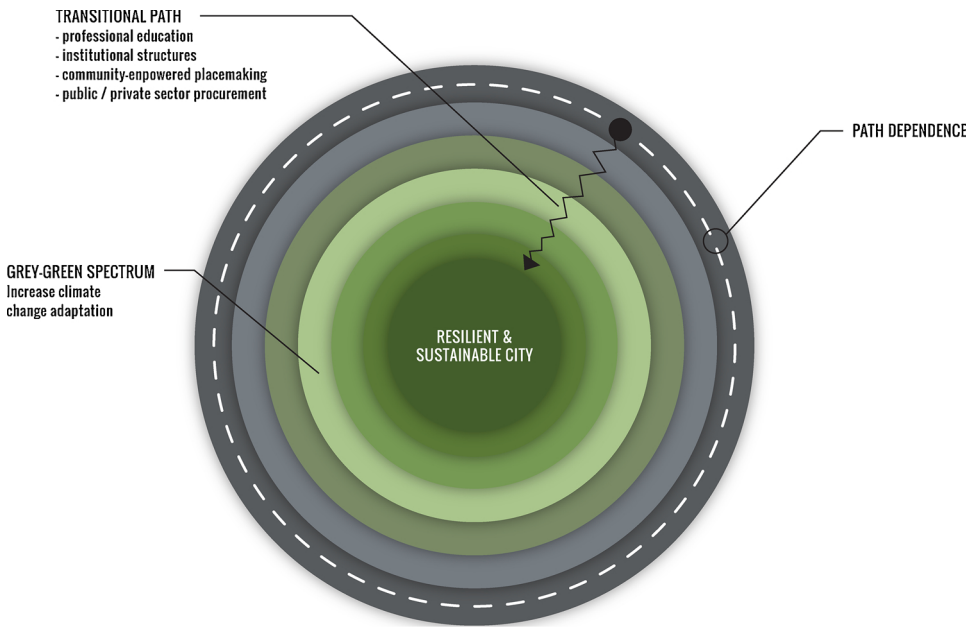

Fig. 1. Conceptual diagram of the transitional path to the widespread adoption of nature-based solutions through simultaneous reforms in four areas. Path dependence in infrastructure ensures that grey approaches are self-reinforcing and remain in perpetual circular motion. The zig-zag line indicates that the transition to nature-based solutions through the proposed reforms is unlikely to be direct. Nevertheless, by progressing through the spectrum (i.e., integrating grey, green and hybrid infrastructure to various degrees) it is possible to arrive at the core – a more sustainable and resilient city delivered through nature-based solutions (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

3. Transition path proposals

3.1. Education of infrastructure professionals

Infrastructure professionals come from many branches of engineering, architecture and city-planning. Their education lies in the hands of training institutions and representative professional bodies (EC, 2018). These institutions and professional bodies need to upscale their training programmes on nature-based solutions (Environment–DHI and UN Environment & IUCN, 2018) and give it as much weight and study time as is presently given to grey infrastructure. This prescription applies not only to new students but to existing in-career professionals as well (Ugolini et al., 2018), with capacity development being delivered through continuing professional development programmes (Harvard Law School, 2014; IHE Delft, https://www.un-ihe.org/about-capacity-development). Institutions can employ the well-tried principles of 'reflective practice' for guidance. There are practical consequences beyond reform of curricula, as tutors may need to be retrained and a variety of under-represented disciplines recruited into departments with non-typical backgrounds. Indeed, there is a case for infrastructure education being taught in transdisciplinary teaching schools. Costs are to be met in respect of these changes, exemplified by the need to prepare new curricula and teaching materials.

3.2. Institutional and cultural reform

A myriad of institutions have evolved a substantial and deep-rooted grey infrastructure culture over many generations. Institutions are generally conservative, and reform rarely comes about without strong external drivers. Moreover, nature-based solutions are a neologism within most institutions. Therefore, to break this self-reinforcement of 'grey over green infrastructure' new transformational leaders should be appointed to reshape institutions from within. This is easier said than done and will require institutions to search outside of their conventional areas of recruitment, bringing in newcomers with fresh insights and an appetite to challenge the status quo. Such changes can be deeply challenging and will certainly be inter-generational. Perhaps more than in other areas the need for reform demonstrates the lock-in effect of path dependence.

3.3. Community-empowered placemaking must also include 'ecosystem literacy'

The public are conditioned to having grey infrastructure wholly meet their needs – an attitude that must evolve, as elicited in our discourse. An innovative style of empowerment linked to placemaking (Williams, 2014) is essential to make this change. The process will require the recruitment of 'change agents' – key personnel working within and outside of public institutions. An example is provided by 'ecosystem-aware community workers' – individuals who can work at the local level, who understand the grey-green spectrum/continuum and hybrid approaches that sit between, how to make it work at the community level and devise nature-based solutions 'with' rather than 'for' local people. We agree with Mattijssen et al. (2017) that "understanding how people relate to places is key for sustainable development". However, the relationship between sense of place and social-ecological systems also requires ecosystem literacy, and we advocate that it be included in educational curricula in much the same way as proposed by Southon et al. (2018) in respect of biodiversity. Gradually, new generations will come to understand that nature-based solutions are at the very least an equal option to grey approaches when it comes to local interventions. In time, this will provide accountable decision makers (e.g., mayors, chief executives) with greater flexibility when deciding how budgets are spent on infrastructure interventions.

3.4. Public and private sector procurement

The public sector and private companies are the main procurers of infrastructure and can make a direct impact through their due diligence processes and spending decisions. Policy makers can intervene at various administrative levels to encourage finance and business models for innovations with nature-based solutions, for example through changing accounting frameworks, adjusting procurement rules and providing risk guarantees (Toxopeus and Polzin, 2017). Accounting rules should incorporate non-monetary values related to nature and procurement rules need to be adjusted to capture the benefits of nature-based solutions, such as improved air quality (Webb and Hawkey, 2017; Toxopeus and Polzin, 2017). Hence, decision makers as major procurers of infrastructure can act as change agents by repeatedly asking, "Can we procure a nature-based solution?"

4. Conclusions

Our core message is that for nature-based solutions to fully take root it is necessary to consider it as a climate-sensitive intervention based on well-performing spatially based green infrastructure networks. However, there is a need to break path dependence if we are to move from grey infrastructure to nature-based solutions, and we have proposed reforms in four areas to achieve this through a transitional path (Fig. 1). In our opinion, change of this magnitude requires the international weight of a respected institution within which an open exchange between disciplines, scientists, researchers and policy makers can take place. Having considered various options, we believe that the appropriate place for this debate to evolve is within the framework of UN Habitat. The Urban Thinkers Campus and World Urban Forum could be the fora for this exchange.

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